"EFFECTIVENESS OF DIGITAL TECHNOLOGY ON ACHIEVEMENT IN MATHEMATICS OF UNDERGRADUATE MANAGEMENT STUDENTS"

Synopsis Submitted to

CMR UNIVERSITY

in Partial Fulfillment of the Degree of

DOCTOR OF PHILOSOPHY
IN
EDUCATION

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2020

DECLARATION

I, Suja Bennet, declare that the thesis entitled **"EFFECTIVENESS OF DIGITAL TECHNOLOGY ON ACHIEVEMENT IN MATHEMATICS OF UNDERGRADUATE MANAGEMENT STUDENTS"** submitted by me for the award of the degree of **Doctor of Philosophy in Education** of **CMR University**, is based on the results of the research work carried out by me under the guidance and supervision of Dr. Praveen R.

I also declare that, this thesis or any part thereof has not been submitted for award of any other degree / diploma of this or any other University / Institution.

Place: Bangalore **Signature of Research Scholar**

Date: **(Suja Bennet)**

CERTIFICATE

This is to certify that, the thesis entitled **"EFFECTIVENESS OF DIGITAL TECHNOLOGY ON ACHIEVEMENT IN MATHEMATICS OF UNDERGRADUATE MANAGEMENT STUDENTS"**, submitted by Suja Bennet, to **CMR University**, Bangalore for the award of the degree of **Doctor of Philosophy in Education** is the result of research work carried out by her, under my guidance and supervision.

This thesis or any part thereof has not previously formed the basis for the award of any degree, diploma, of any other University or Institution.

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1 INTRODUCTION

Education is a process of nurturing and nourishing the innate learning potential of children by creating an environment managed by a developmental program involving care and education, i.e., 'Educare', originated from the Latin word means 'to bring up' (Sahu, 2002, p. 9; Shankar, 2015). Nelson Mandela described education as "the most powerful weapon" that could be used to improve the world. In fact, it is the foundation for the socioeconomic development of individual and nation (Memon et al., 2007; Paas, 2008).

The Indian education system originated from the Gurukul, where both students and teachers dwell in the same place (Shankar, 2015). Education has the primary goal of overall progressive development of the innate abilities of the learner. Moreover, education is an information transfer process using different media from one generation to the next generation (Misra & Joshi, 1995, p.11). An evolution in educational and information technology are the main driving force for education development (Pahl, 2003). Over the period of time, the old blackboard method has been replaced many times by digital methods. Computer technology and digital media are being used for teaching purposes such as audio visual presentations, demonstrations and virtual classroom projects. There was an interrelation between organization, curriculum, infrastructure and pedagogy during building of teaching and learning environment (TLE) (Pahl, 2003).

Bloom and his colleagues had categorized learning into three domains mainly: cognitive (Knowledge based), affective (attitude based) and psychomotor (skill based) (Anderson et al., 2001; Simpson, 1972; Bloom et al., 1956). Moreover, today's age is of technology age, which has transformed our lives and introduced many reforms in many educational institutes in order to provide personalized education (Christensen, Horn and Johnson, 2008; Collins and Halverson, 2009; Woolf et al., 2010).

1.1 Use of Digital Technology in Higher Education classrooms

Todays' employers need professional people who are skilled and also possess qualities such as leadership, good oral and written communications, critical thinking, problem solving, good work ethics, teamwork and collaborative abilities. The application of digital technology increases the creativity and thinking capabilities of the students and

they become well versed with the use of technology on a regular basis (Henriksen, Mishra and Fisser, 2016). Educators also use digital technology in the classroom, hence the students become more acquainted with the recent advances in technology. Therefore, pedagogical practices have been greatly affected by advancements in technology and science. Digital technology in higher education help the students to capture resources (e-books, educational videos and online course materials) and understand the topic in a better and easy way. Hence, this comes with the challenges of quality and authenticity of material provided online (Akbar, 2016).

1.2 Use of Digital Technology in Mathematics Education

Mathematics is one of the crucial subjects in the curriculum of higher studies, which act as a decisive filter during selection of educational and career opportunities (Kuenzi, 2008). Mathematics education basically deals with the learner's ability to understand and solve problems, which many times associated with problems of mathematics anxiety (Tapia and Marsh; Peters, 2013). Content specific digital technology, such as analysis devices, computer based applications, interactive applets, dynamic geometry environments and computer algebra system, have been employed in mathematics. Games have been one of the main educational tools in mathematics for generations. In the 21st Century, digital technology and digital games have been used as an efficient pedagogical tool for teaching mathematics and the strategic use of these technology could fortify mathematics teaching and learning

1.3 Mobile Devices in Higher Education Classrooms

The evolution in the portable device technology has resulted in the change in the usability of mobile devices in the education system. Many researches have focused their research on the utilisation of mobile devices (Bring Your Own Device-BYOD) and its effectiveness in learning and teaching in higher education (Sevillano-García and Vázquez-Cano, 2015; Gikas and Grant, 2013; El-Hussein, Osman and Cronje, 2010). The BYOD are not only helpful to nurture learning activity, but also found to be effective during the processes of learning and teaching in higher education (Sevillano-García and Vázquez-Cano, 2015). The extended use of Massive Open Online Courses (MOOC) also facilitates the educator and learner towards the use of BYOD due to easy accessibility and flexibility.

1.4 Learning Management System in Higher Education

The learning management system (LMS) has been substantially focused due to ICT development in over the years, which is cloud or server based software program that aid in teaching learning process in order to deliver effectively during training and developmental programs. The LMS is defined as "a software application for the administration, documentation, tracking, reporting and delivering by e-learning education courses or training programs" (Ellis, 2009). LMS is used in many higher educational institutes and various industries, primarily designed to deliver lectures, which is based on interaction between learner and educator or instructor, i.e. two way communication. LMS can be categorized into three groups, namely, cloud based LMSs, propriety LMSs and open source LMSs, which are based on either the open source code or proprietary software that require installation. Cloud based LMSs does not require installation of the software (Dobre, 2015; Aldheleai, Bokhari and Alammari, 2017).

Learning Management System has many advantages such as increased accessibility and flexibility, improvement in pedagogical strategies and cost effective (Chaubey and Bhattacharya, 2015). Furthermore, LMS provides a structured virtual learning experience and authentic teaching and learning environment without any time and distance restriction (Epping, 2010; Chaubey and Bhattacharya, 2015). However, LMS has few disadvantages also such as course centred instead of student centred, increase teacher's workload, trainers with poor computer knowledge and challenged teachers for designing and organizing learning activities according to the student's needs, teaching skills and styles (Sharma and Vatta, 2013).

1.5 Statement of the Problem

Today's management education in India is very competitive and demanding due to the participation of government and private institutions. Hence, it undergoes constant improvement in terms of facilities and quality of education, which include effective teaching using different pedagogical methods. In order to do that, digital technology have been utilised to increase the quality of education and improve performance and engagement of students during the learning process (Casey and Jones, 2011; Basha and Altaf, 2012). Nowadays, the use of advanced digital technology and resources such as video conference, email, blogs, wikis, discussion forums, chat groups, Facebook and other social sites have been used for active learning purpose, which impose the problem

of embracing poor study habits in search of a shortest possible method to solve mathematics problems, which is gained while using traditional methods. Another problem is cyber bullying that is gaining immense focus where youngsters become trapped due to illegal crimes without their consent or knowledge. Moreover, there can be wastage of valuable time due to server problem or excess use of social networking sites for constant updating their profile rather than studying. Considering all the problems related to the use of digital resources, the present research was undertaken to determine the efficiency of digital technology on achievement in mathematics of undergraduate management students.

The present study is entitled as,

"Effectiveness of digital technology on achievement in mathematics of undergraduate management students"

1.6 Purpose of the Study

The primary aim of the present study was to determine the effectiveness of usage of digital technology in classrooms with particular references to the internet, wireless and mobile technology and to measure impact of the integrated framework of E-Learning and M–Learning platforms and devices for teaching and learning process on achievement in mathematics of undergraduate management students.

1.7 Significance of the Study

The significance of the present is in the educational field due to the fact it has focused on the use of digital technology, especially mobile devices in educational institutes, which is used as a pedagogical tool in teaching and learning. Researchers have focused on the various aspects of digital technology and resources use in higher education over the period of time (Buzzard, 2011; Basha and Altaf, 2012; Gikas and Grant, 2013). Technology adaptation in the pedagogical practices in educational institutes would have a positive effect on student inclusion in the classroom and also benefit educators for delivering lectures in a more effective way. Incorporation of ICT and digital resources help to motivate students and increase student's attention and maintain communication between educator and learner (De Vita, Verschaffel and Elen, 2014; Francis, 2017). According to Arroyo et al. (2013), female students were affected positively and became

more productive and receptive by the use of digital technologies as a pedagogical tool in mathematics education. On the contrary, Dixon et al. (2014) reported that there was a significant difference in the use of digital technologies and internet between male and female gender and female are poor users of digital technologies. Hence, the significance of the present study lies in the evaluation of digital technologies to measure the impact of digital technologies on various aspects student outcomes studying in an undergraduate management course.

1.8 Research Questions

The present study addresses the following research queries.

1. Would the use of digital technology have an effect on the achievement or student engagement in mathematics through deeper learning?

2. Do digital technology have a differential influence on the mathematical accomplishment of students of different gender?

3. Do digital technology have a differential influence on the mathematical accomplishment of students from different educational background?

4. Would the use of digital technology have an impact on the students' attitude towards mathematics?

5. How receptive are students to learn in a digital environment?

6. What are the constraints encountered during the implementation of a digital environment in the classroom?

1.9 Objectives

1. To develop pedagogical strategy for the use of digital technology on selected topics of Undergraduate Management Mathematics syllabus.

2. To identify the effectiveness of digital technology on achievement in mathematics of male and female Undergraduate Management students.

3. To identify the effectiveness of digital technology on the achievement in mathematics of Undergraduate Management students belonging to different educational background.

4. To investigate the interaction effect of gender and educational background of Undergraduate Management students with respect to achievement in mathematics.

5. To identify the effectiveness of digital technology on the attitude of Undergraduate Management students towards mathematics.

6. To comprehend Under-Graduate Management students' opinions about the digital learning environment.

1.10 Research Hypotheses

Hypothesis 01: There is no significant difference between Experimental group and Control group with respect to pre-test scores of achievement in Mathematics.

Hypothesis 02: There is no significant difference between Experimental group and Control group with respect to post-test scores of achievement in Mathematics.

Hypothesis 03: There is no significant difference between male and females of Experimental group with respect to post-test scores of achievement in Mathematics.

Hypothesis 04: There is no significant difference between the students of Experimental group who had opted science stream and who had opted commerce stream prior to graduation with respect to the post-test scores of achievement in Mathematics.

Hypothesis 05: There is no significant difference between the students of experimental group from state board and from non-state board prior to graduation with respect to the post-test scores of achievement in Mathematics.

Hypothesis 06: There is no significant difference between the students of the experiment group who had opted mathematics and who had not opted mathematics prior to graduation with respect to the post- test scores of achievement in Mathematics.

Hypothesis 07: There is no significant main and interaction effect of gender and stream of the experimental group with respect to the post-test scores of achievement in Mathematics.

Hypothesis 08: There is no significant main and interaction effect of gender and board of education of the Experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 09: There is no significant main and interaction effect of gender and mathematical background of the experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 10: There is no significant main and interaction effect of the stream and board of examination of the Experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 11: There is no significant main and interaction effect of board and mathematical background of the Experimental group with respect to the post-test scores of achievement in Mathematics.

Hypothesis 12: There is no significant difference between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the gender.

Hypothesis 13: There is no significant difference between the post-test scores of achievement in Mathematics of the Experimental group and Control group based on the educational background.

Hypothesis 14: There is no significant difference between the post-test and delayed post-test scores of Experimental group with reference to achievement in Mathematics.

Hypothesis 15: There is no significant difference between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics based on the gender.

Hypothesis 16: There is no significant difference between post-test and delayed post-test scores of Experimental group on achievement in mathematics based on the educational background.

Hypothesis 17: There is no significant difference between pre-intervention and post-intervention amongst Experimental group with reference to attitude towards Mathematics.

1.11 Scope of the Study

The present research will be useful in determining the effectiveness of various digital technology and resources on the achievements in mathematics of undergraduate management students. The present research concentrates on the use of digital technology in order to increase students' engagement in the classroom. The findings of the present study need not be only applicable to mathematics course or management program, but can be extended to other courses and professional programs too.

1.12 Operational Definitions

In order to convey certain meanings, a number of concepts and terms have been utilised in the present study. The following sub-sections describe the concepts and terms utilised in the present study.

Effectiveness

Effectiveness indicates the degree of change in the level of achievement in mathematics of undergraduate management students who have been subjected to the intervention of digital technology in the learning of mathematics.

Digital Technology

Digital technology refers to the use of resources, devices, systems, and electronic tools that process, store or generate data. In other words, a teaching and learning environment

that is created which encompasses the digital resources accessed through the web interface, customized application software and mobile devices.

Achievement in Mathematics

Achievement in mathematics is an individual's level of understanding of data and the subsequent skilfulness demonstrated, generally due to instructions imparted in the course. Undergraduate management students undertake tests formulated and validated by the researcher and their scores denote the achievement in mathematics.

Attitude toward mathematics

Attitude towards mathematics is denoted by the students' coordinated sensitivity to perceive, feel, think and behave about mathematics (Jovanovic and King, 1998).

Intelligence

Intelligence is an individual's capability of reasoning by analogy (free from formal schooling and language) and of forming perceptual associations. Students' scores in Standard Progressive Matrices (SPM) (developed by Raven, 2004) represent their intelligence in the present research.

Gender

Gender is the state of biological characteristics that differentiate males and females.

Educational Background:

In this study, educational background refers to the students from different streams such as Science and Commerce, from different boards of examination namely state board and non-state board and whether they have pursued Mathematics or not at the higher secondary or Pre-University level prior to pursuing graduation.

2 REVIEW OF RELATED LITERATURE

The present study aimed to assess the impact of digital technologies on achievement in mathematics in higher education students and to assess if there would be differences in the effectiveness of digital technologies based on demographic factors of the learners.

In order to gain valuable insights into prior research conducted in this area, a thorough review of the literature was first performed at three levels: to understand the utilisation of digital and web resources, mobile devices and Learning Management Systems (LMS), within the context of higher education, across different domains such as physics, chemistry, social sciences, business, etc. The review was then narrowed down to the utilisation of digital technologies within classrooms for the purpose of teaching mathematics.

Alhajri (2016) investigated the perceptions of students and instructors towards mobile learning by conducting a survey of 499 students and 110 instructors. Both the categories of respondents expressed their satisfaction towards mobile learning. The study however found gender to be a cultural issue in implementing mobile learning in Kuwait as most of the respondents did not exhibit willingness to collaborate with their opposite genders through mobile learning platforms. Both students and instructors also projected the belief that social media programmes introduced family-related difficulties, even though it can be used in collaborative learning. The study also established that instructors of Kuwait did not perceive mobile learning as an addition burden, but as a valuable opportunity. In conclusion, the extent of mobile learning utilised was far lower than the extent of ownership of mobile devices.

Setirek and Tanrikulu (2015) studied the development factors influencing mobile learning and the sustainability of mobile learning by conducting a survey of 36 selected lecturers of 12 different universities of Turkey. Learning environment factors such as novelty, usability, interactivity, etc., factors related to materials, content related factors, compatibility, innovation, testing and evaluation factors were identified as significant factors determining mobile learning in universities of Turkey.

Cochrane (2014) evaluated the effects of integration of an undergraduate product design programme with mobile web 2.0 technology on the experiences of students as well as teachers as well as to uncover the obstacles impeding implementation of mobile learning. The students were given Nokia N80 smart phones and the lecturers Nokia N95 smartphones along with foding keyboards for their lectures. The results revealed positive experiences of students as a result of flexibility of content, virtual presentations made possible and collaboration via bogging, confirming the onset of heutagogy in the place of pedagogy.

Cochrane and Narayan (201) integrated a lecturer developmental course with mobile technologies based on the COP model, a novel e-learning model developed by the researchers to achieve the transformation of instructivist paradigm to social constructivist paradigm with the help of more than 30 mobile learning projects implemented between the years 2006 and 2010. The COP model proposed a successful way of integrating innovative technologies with the course curriculum. The study involved seven participants who had access to laptops and iPhone 4 to take up the course. The participants were expected to create their own learning environment using an assortment of web 2.0 tools such as Twitter, blogs, Wikipedia, etc. using Moodle LMS as the scaffold. As a result of integration with mobile tools, the researchers observed a shift in ontology of the participants from pedagogy to heutagogy as well as better student engagement.

Vlachopoulos and Makri (2017) reviewed the different kinds of games such as serious games, interactive games, video games, simulations, micro-simulations, etc. in influencing the pedagogy in various fields of university education and assessed the subsequent student outcomes. Results of the meta-analysis indicated that games and simulations positively influence the learning objectives of students in terms of cognitive, affective as well as behavioural learning, thereby emphasising the role of digital technology in promoting participatory learning.

Sitti, Sopeerak and Sompong (2013) verified if course delivery based on connectivism learning theory enabled by ICT practices such as social networking sites influenced university students' everyday problem solving skills as well as learning abilities in terms of awareness of resources, connection with them and contribution to the networks formed, the first three levels of taxonomy of connectivism. An instructional model based on connectivism was developed and evaluated by a focus group encompassing 10 educational experts from Thailand. As a result of such an instructional model, the problem solving skills of students were found to improve.

Cilliers, Ntlabathi and Makhetha (2017) posited that South African universities considered LMS as the solution to tackle with the large number of students within classrooms. When the level of implementation of LMS in 31 different classes over a period of 3 years was assessed, course management was identified as the crucial aspect of using LMS. The study revealed that collaboration and introduction of different

pedagogy styles as a result of LMS was not yet achieved by the university, that LMS was mostly used as a management tool for basic communication and evaluation purposes only.

2.1 Research gap

A major research gap identified while conducting the literature review was the lack of studies pertaining to digital learning environments within Indian higher education classrooms. In spite of the rapid advancements in the digital infrastructure and implementation of advanced technologies across colleges in India, research studies assessing the level of implementation, outcomes and determinants of outcomes were found to be scanty. Most of the studies in the Indian context discussed the transition of Indian education towards an electronic paradigm (Bhattacharya & Sharma, 2007) or discussed the barriers encountered during implementation (Khan, Hossain, Hasan & Clement, 2012) or scope of implementation (Anuradha & Usha, 2006), but not on the performance aspects of students. Findings of the present study can bridge this research gap and further put forth outcomes specific to mathematics achievement of students.

3 METHODOLOGY

3.1 Method of Research

Research approach can be sorted into five different groups depending upon the methods (Pandey and Pandey, 2015) such as philosophical, historical, survey, experimental and case studies. The choice of method is dictated by the nature of the research problem. On the basis of our research objectives, experimental method was selected for our study as the current study intends to evaluate the effectiveness of digital technology on the mathematics achievements in the learning of mathematics of the management students, which can be evaluated only through experimental set up rather than any other way, justifying its application. Experimental research pursues to evaluate when the specific treatment/condition impacts a consequence (Cresswell and Cresswell, 2017). The researcher can measure this by applying the specified treatment/ condition to one group and withholding it from another and then determining how both groups scored on the consequence.

3.2 Research Design of the Study

A quantitative approach was proposed for the present study, which aims to examine the effectiveness of usage of digital technology in classrooms where higher education is being imparted. As an experimental design was adopted, a non-equivalent group design (pre-test, post-test and delayed post-test) was followed. The study population comprised of first-year undergraduate management students. Since the program has a predefined curriculum and schedule, the treatment was carried in the second semester of first-year students. The two random non-equivalent groups from two sections of the same batch were selected. Pre-test on Achievement in Mathematics and Intelligence were administered to both groups to assess their homogeneity. After determining the groups, the control group was exposed to a conventional mode of teaching, whilst the experimental group was taught in a digital technology environment. The researcher used an integrated framework of digital resources accessed through the web interface, which deemed fit to treat the modules, customized application software and mobile devices as shown in the figure below. After the instruction period ended, both groups were subjected to the Post-Test on Achievement in Mathematics. The delayed post-test was administrated to the experimental group within a month after the completion of the instructions and administration of the Post-Test on Achievement in Mathematics. Students in the experimental group were also administered the Mathematics Attitude Scale and an opinionnaire after the intervention.

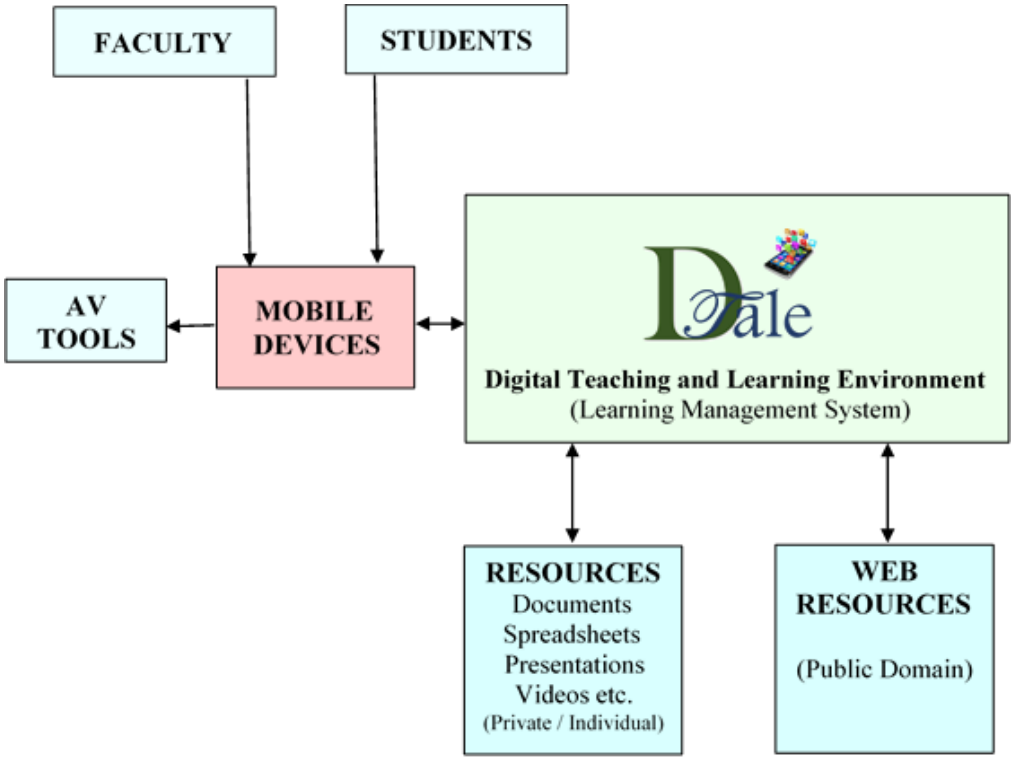

Figure : Integrated Digital Teaching Learning Environment Framework

3.3 Variables of the Study

A study variable has been defined as the 'characteristic attributes' of the assumed factors that can be evaluated easily which explains the 'proposed cause' of the 'proposed outcome' (Field, 2013). Variables can be classified into different types, namely, Independent, Dependent and Moderator variables.

Independent Variables:

Typically, those features which are being considered as probable reasons of cause are known as independent or predictor variables. The independent variables considered in our study include:

a) Treatment using digital technology and

b) Conventional method of teaching mathematics.

Dependent variables:

The outcome of the causes is regarded as dependent variables. The following are the dependent variables selected for the present study.

a) Achievement in mathematics

b) Attitude towards mathematics

Moderator variables:

Moderator variables have been described as the factor that alters the strength or the direction of any impact, which is caused on the other dependent variable by the independent variable (Hayes, 2013). Gender and educational background are the moderator variables, in the study.

3.4 Hypotheses of the Study

Hypothesis 01: There is no significant difference between Experimental group and Control group with respect to pre-test scores of achievement in Mathematics.

Hypothesis 02: There is no significant difference between Experimental group and Control group with respect to post-test scores of achievement in Mathematics.

Hypothesis 03: There is no significant difference between male and females of Experimental group with respect to post-test scores of achievement in Mathematics.

Hypothesis 04: There is no significant difference between the students of Experimental group who had opted science stream and who had opted commerce stream prior to graduation with respect to the post-test scores of achievement in Mathematics.

Hypothesis 05: There is no significant difference between the students of experimental group from state board and from non-state board prior to graduation with respect to the post-test scores of achievement in Mathematics.

Hypothesis 06: There is no significant difference between the students of the experiment group who had opted mathematics and who had not opted mathematics prior to graduation with respect to the post- test scores of achievement in Mathematics.

Hypothesis 07: There is no significant main and interaction effect of gender and stream of the experimental group with respect to the post-test scores of achievement in Mathematics.

Hypothesis 08: There is no significant main and interaction effect of gender and board of education of the Experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 09: There is no significant main and interaction effect of gender and mathematical background of the experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 10: There is no significant main and interaction effect of the stream and board of examination of the Experimental group with respect to the post-test scores of achievement in Mathematics

Hypothesis 11: There is no significant main and interaction effect of board and mathematical background of the Experimental group with respect to the post-test scores of achievement in Mathematics.

Hypothesis 12: There is no significant difference between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the gender.

Hypothesis 13: There is no significant difference between the post-test scores of achievement in Mathematics of the Experimental group and Control group based on the educational background.

Hypothesis 14: There is no significant difference between the post-test and delayed post-test scores of Experimental group with reference to achievement in Mathematics.

Hypothesis 15: There is no significant difference between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics based on the gender.

Hypothesis 16: There is no significant difference between post-test and delayed post-test scores of Experimental group on achievement in mathematics based on the educational background.

Hypothesis 17: There is no significant difference between pre-intervention and post-intervention amongst Experimental group with reference to attitude towards Mathematics.

3.5 Sampling Procedure

Purposive sampling technique was followed in the study. A suitable college in Bangalore was selected to conduct the experiment. A college affiliated to Bangalore University was selected as it offered management programme at the undergraduate level. Also the minimum strength of the students in a section was forty. Moreover the student population comprised of both the genders; comprised of students who prior to graduation pursued either science or commerce streams, took different boards of examination, had studied mathematics or had not studied mathematics. Moreover, the institution was open to permit the use of their IT infrastructure to implement the digital teaching and learning environment and to conduct the experiment. The researcher decided to conduct the experiment in intact classroom group.

The sample of the study comprised of 80 students of undergraduate management programme -Bachelor of Business Administration, Batch of 2016-2017. For the experimental group, a total of 40 students from Section A was chosen. Equal number of students were also selected from Section B as the control group. Pre-tests were administered to the groups to verify the homogeneity of the groups. Intelligent test (Standard Progressive Matrices - SPM) and Mathematical Achievement Test were the two pre-tests employed for the verification of homogeneity. For the administration of the try-outs for Pre-Test and Post-Test on Achievement in Mathematics, over 70 students of undergraduate management programme - Bachelor of Business Administration batch of 2016-2017 was selected.

3.6 Tools used for the Study

The following tools were used for collection of data on different variables of the study:

1. Mathematics Attitude Scale developed by Ali Imam and Tahira Khatoon (2012) to measure students' attitude towards mathematics.

2. Standard Progressive Matrices by J.C.Raven (2004) to measure the intelligence of the students.

3. Achievement in Mathematics (Pre-Test) developed by the researcher to measure the achievement in mathematics of the students.

4. Achievement in Mathematics (Post-Test) developed by the researcher to measure the achievement in mathematics of the students.

5. Opinionnaire developed by the researcher to solicit opinion of the students about their experience of learning in an integrated digital teaching and learning environment.

3.7 Statistical techniques used

The study design involves the empirical analysis of data using statistical SPSS software by performing the following tests: (i) Descriptive statistics, (ii) t-test and ANOVA.

The following sections briefly describe the various tests.

Descriptive statistical analysis

The elementary characteristics of the gathered data are explicated by using descriptive statistical analysis. This was accompanied by the measures, simple graphs, and sample summaries. The percentages and frequencies of observations that exist for each data component or group of data components are illustrated by using these tests (Cohen, 1988). The mean is the sum total of all the data values divided by their frequencies. The middle tendency in the data is reflected by the mean. Standard deviation is the

quantity of variation within the data. It is calculated based on square root of squared deviations of the observed values in the data set from the mean value.

Independent t-test

The mean values of two unrelated groups on the same continuous dependent variable are compared by using independent t-tests. Any association between the means of two independent groups or their difference is determined by independent t-test.

Analysis of Variance

Similarly, the means of more than two populations are compared by conducting a two-way analysis of variance (ANOVA). The difference in populations is determined by conducting Tukey's multiple comparison post-hoc tests. Main effect is the effect on the dependent variable by one of the independent variables; while an interaction effect occurs when there is an interaction among the independent variables, which affect the dependent variable. Study of two factors and interaction between these two factors can be done simultaneously. Testing for the existence of relationship between an independent variable and the dependent variable is the generic principle in Interaction effect.

3.7.1 Reliability and Validity

Reliability of Tools:

Reliability analysis examines the internal consistency of the instruments' foundations used for study. This is the measurement of the quality of the questionnaire. It is done by scaling the degree of inter-correlation within the questions. It is the most favoured form of study as it necessitates a single administration and has been found to be the most effective in field studies. The most common method of analysing reliability through internal consistency and unidimensionality is by calculating the Cronbach's Alpha (Cronbach, 1951). This value varies from a scale of zero to one. When the value of α is close to one, it can be interpreted as having a higher level of internal consistency for that item in the questionnaire. Usually, the acceptable cut-off value for Cronbach's alpha is set at 0.60, it is considered to be satisfactory from 0.7 to 0.8, it is considered to be good from 0.8 to less than 0.95, and beyond 0.95 is considered as redundant items by testing the same question (Hinton et al., 2014; Bland and Altman, 1997).

Validity of Tools:

Validity is the statistical quantity of a questionnaire's ability to evaluate variables that are linked to the study (Davidshofer & Murphy, 2005). Predictive validity, construct validity and content validity are the three types of validity testing. The relation between the individual items and the measured concept is evaluated by content validity (also known as face validity). The practical manifestation of a test for evaluating the assessable construct is often referred to as construct validity. Factorial analysis was used to evaluate the construct validity.

Factor analysis deals with a set of variables, which are supposed to be linked to the area under study. This is done to recognize any unique, meaningful components within the co-variables among the set of other variables. The validity of the factor analysis can be measured primarily through the appearance of a simple, understandable structure. Principal Component Analysis (PCA) using Varimax rotation was used to maximize the variance of each factor. The constructs column represents the final core factors that have been extracted after data reduction. Factors with an Eigenvalue of 0.4 to 1 were selected for loading in accordance with the guidelines for evaluating the loading strength (Hair et al., 1992, Straub, 1989). In order to facilitate a better reading of the outcomes, the factors that loaded below 0.4 were suppressed (Samuels, 2016). The research instrument's validity is indispensable for comprehending the quality of concept defined by the measures.

Exploratory Factor Analysis (EFA) is a measure to identify the ability of a questionnaire. EFA was accomplished to ensure that the questionnaire contained all perceptions it was expected to measure. Generally, the Kaiser-Meyer-Olkin (KMO) test is used to measure the sampling adequacy and is used to test if the distribution of values was adequate for conducting factor analysis. Two important tests that show the relevance of the data and evaluates the degree of inter-correlations among the variables are Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests of Sphericity. While KMO measures the sampling adequacy of the data collected (Kaiser, 1970), Bartlett's tests evaluate the significance of correlation matrix (Bartlett, 1954). Based on these facts, the nature of the variance between the factors was determined in factor analysis. The KMO values that are examined between 0 and 1 and higher values indicate that the sampling is adequate. The acceptable limit for KMO values of individual items should

be a minimum value of 0.5, while values from 0.6 to 0.8 are moderate and values above 0.9 are considered to be excellent (Field, 2013). A KMO value of more than 0.6 and a Bartlett's Test of Sphericity value of 0.000 indicates that the answers obtained from questionnaire are satisfactory to measure the problem that is being evaluated in the study and factor analysis can be achieved.

3.8 Procedure of the Study

This research was broadly divided into 2 phases: Pre-intervention and Post-intervention.

Within Pre-intervention of administration of Mathematics Attitude Scale to 342 undergraduate management students, the demographic details of the study population and the three dimensions of Mathematics Attitude Scale, namely, confidence in learning mathematics, usefulness of mathematics and enjoyment of mathematics and overall student's attitude towards mathematics were evaluated. The reliability and validity of the Mathematics Attitude Scale questionnaire was also investigated. Moreover, statistical analysis was carried out to measure the perception of dimensions of Mathematics Attitude Scale based on the demographics. This was followed by administrating the intelligence and achievement test. The intelligence test was conducted only in the pre-intervention phase for ensuring the homogeneity of the groups (experimental and control) that were considered for further study. The mathematical achievement pre-test was administered to check the proficiency of the students in mathematics; therefore, conducted in three stages, namely, draft, try-out (pilot) and final. The try-out was conducted on 71 students of the under-graduate programme of the same batch. After finalizing the questions through reliability, the final test was conducted for both experimental and control groups (N = 40).

The Post-intervention studies were carried out in three phases, Achievement test, Mathematical attitude and Opinionnaire. In this case, the Post-test on Achievement in Mathematics was conducted in four phases: a draft, try-out (pilot), final and delayed. The reliability of the try-out post-test was assessed, followed by the comparison of mathematical achievement scores of the control and experimental group post-intervention. The differences in the achievement test based on the demographics of the students were evaluated. The fourth phase comprised of delayed post-test wherein the

students were again administered the same post-test after a month to determine the mathematics retention ability which they had imbibed through the intervention. This phase was conducted only among the students in the experimental group. The perception of students on various aspects of the Integrated Digital Teaching Learning Environment was understood using an Opinionniare, which comprised of a set of questions to determine what the students felt about the new environ of learning; how it has impacted their perception of learning mathematics. The demographic profile of the students of the Opinionnaire was solicited. This was followed by the perception of students on using a Learning Management System, its challenges and achievements. The Opinionnaire was initially tested for reliability and validity of study variables. Finally, the change in attitude towards mathematics after intervention was studied by administering the Mathematics Attitude Scale to the experimental group and compared with the pre-intervention scenario.

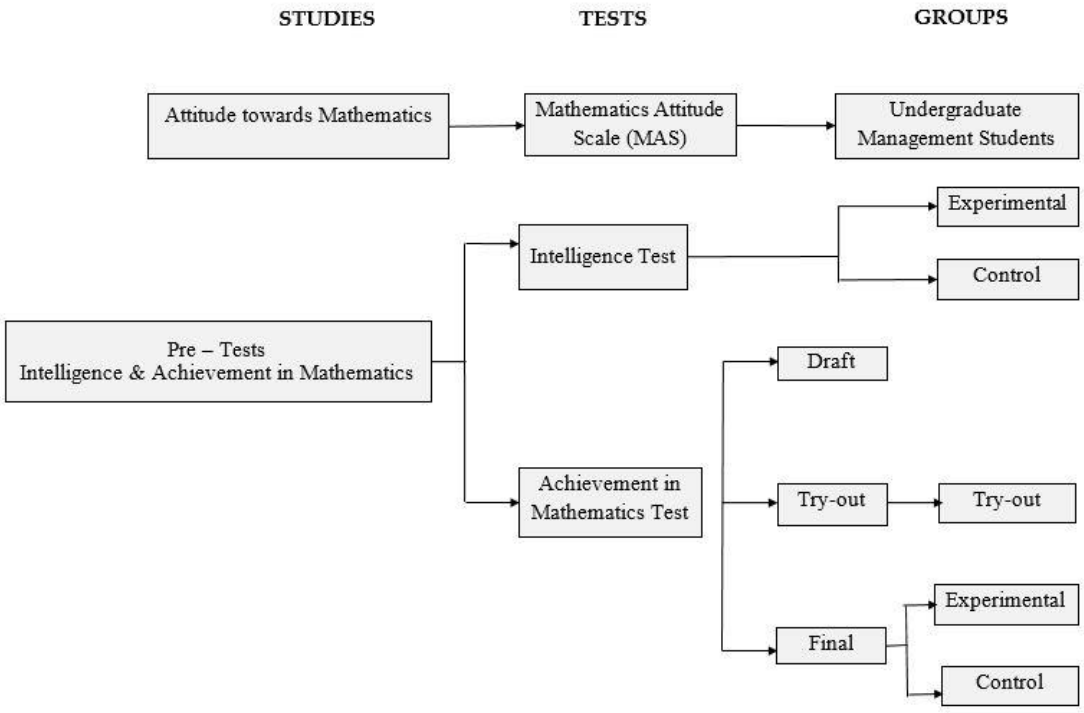

Figure : Framework of the Pre-Intervention Phase of the Study

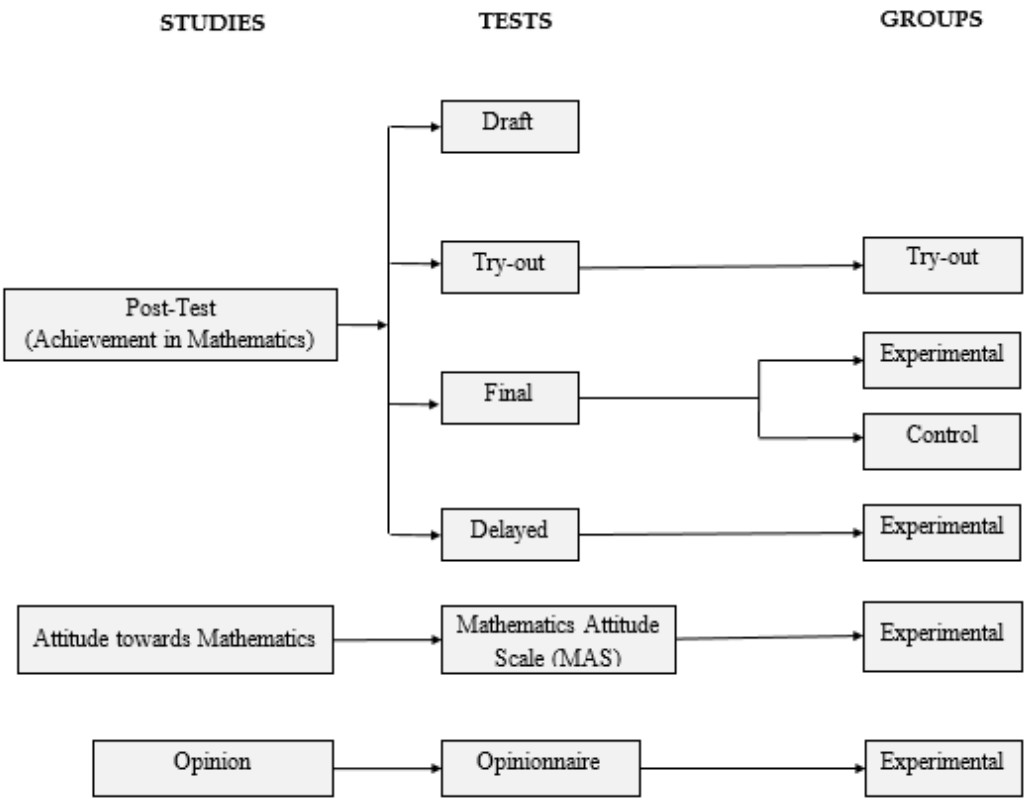

Figure : Framework of the Post-intervention Phase of the Study

3.9 Stages in the Design of the study

The design of the present study involved various stages with various phases. The study can be categorised into four-staged activities, which are elaborated in Table given below.

Stages of the Study

Stage	Activity
Stage 1	Development of Learning Management System (Digital Teaching and Learning Environment - DTale)
	Mathematics Attitude Scale (MAS) and its administration
	Development of lesson plan for experimental group as well as control group
	Selection of the sample

Stage 2	Construction of the Pre-Test on Achievement in Mathematics
	Construction of the Post-Test on Achievement in Mathematics
	Construction of the Opinionnaire
Stage 3	Conduct of the Experiment
	Phase 1: Administration of Pre-Tests to Experimental group as well as Control group
	Intelligence Test
	Achievement in Mathematics Test
	Phase 2: Conduct of the Instruction to both Experimental group as well as Control group
	Phase 3: Administration of the Post-Test in Mathematics Achievement to both Experimental group and Control group
	Phase 4: Administration of the Delayed Post-Test in Mathematics Achievement to the Experimental group
Stage 4	Administration of Mathematics Attitude Scale to the Experimental group
	Administration of Opinionnaire to the Experimental group

4 SIGNIFICANT FINDINGS

I) Pre-intervention

A) Pre-intervention: Administration of Mathematics Attitude Scale (MAS)

Demographic details of the students

- Out of 342 students who were administered the Mathematics Attitude Scale (MAS) assessment, the majority of them were Indian (93.6%) males (68.1%) with commerce background (85.1%) and was from the state board (83.3%). Further a small percentage (30.7%) of the study population had mathematics background.

Mathematics Attitude Scale

1. Confidence in learning mathematics

- The students found mathematical problems were boring, time consuming and difficult to learn. It can be assumed, frequency of mathematics test in school led to stress and headaches among students.

2. Usefulness of mathematics

- Mathematics, as a compulsory subject in class, helped to develop concentration, improve abilities and make an individual effective worker. In contrast, students also commented on requiring extract effort, unworthiness and uselessness of the subject.

- Students expressed mixed feelings with respect to recommending Mathematics to friends for higher studies because they were neutral about giving advice to their friends for choosing Mathematics in the higher classes, continuing its studies , the fact that none of them will choose to study Mathematics and the presence of Mathematics as an optional subject.

3. Enjoyment of mathematics

- Students were not clear whether they enjoyed, were at ease or required Mathematics, similar to other courses.

Overall Student's attitude towards mathematics

- Overall, the student attitude towards mathematics was moderately favourable to extremely unfavourable.

Perception of Mathematics Attitude based on demographics of the students

A) Perception of Confidence in Mathematics

- Male students from a science background and non-state board, irrespective of their nationality, displayed a higher level of confidence in mathematics.
- Mathematics at the senior secondary level increased the confidence of students in mathematics, however, this confidence was not related to the nationality of the students.

B) Perception of Usefulness of Mathematics

- Male students with foreign nationality, who chose science in senior secondary level found mathematics to be useful.
- Students from non-state board and with a mathematical background found mathematics to be more beneficial.

C) Perception of Enjoyment of Mathematics

- Male students who had science at the senior secondary level and with a mathematical background, irrespective of board and nationality, enjoyed mathematics. However, with respect to nationality there was no difference.

A) Pre-intervention: Comparison of Intelligence test scores of control and experimental groups

Intelligence test

- There was no significant difference in the intelligence scores between Control group and Experimental group.

B) Pre-intervention: Achievement test in Mathematics

- There was no significant difference between Experimental group and Control group with respect to Pre-Test scores of Achievement in Mathematics.

II) Post-Intervention

A) Post- Intervention: Achievement test in Mathematics

- An integrated digital teaching learning environment (a LMS supporting BYOD, mostly the mobile, tablet or laptop approach) was used to teach mathematics to the experimental group, whereas the control group was taught mathematics in the traditional way and achievement tests were conducted.

Difference between the scores of control and experimental groups based on the Achievement in Mathematics after intervention

- Based on a t-test, it was found that the achievement in mathematics after the intervention had a significant difference between the experimental and control group.

Differences in achievement test score post intervention based on demographics of the students

- Using student's independent t-test it was shown that achievement in mathematics post-intervention was independent of gender, suggesting that both male and female were equally benefitted from the digital learning environment.

- Irrespective of the student's background, whether the student was from commerce or science stream prior to graduation, there was no statistical difference in their achievement in mathematics post-intervention.

- Based on the t-test results, it was found that the examination board (state or non-state) did not influence the achievement test scores post intervention, which indicate that irrespective of board, students had similar achievement in mathematics.

- Based on t-test, it can be inferred that, the prior knowledge of mathematics at senior secondary level did not influence the achievement test scores post intervention.

- Based on ANOVA, it can be concluded that there is no significant main and interaction effect of gender and stream of the experimental group with respect to the post-test scores of achievement in Mathematics.

- There was no significant main effect of gender on the scores of post intervention achievement tests, as measured by ANOVA. However, board of examination of students had a main effect of the scores of post-intervention achievement tests. The effect size was observed to be high, implying large amount of association. In addition, there was an interaction effect observed between gender and board of examination on the scores of the achievement tests. The effect size was observed to be high, implying large amount of association.

- There was no significant main and interaction effect of gender and mathematical background of the experimental group with respect to the post-test scores of achievement in Mathematics, as measured by ANOVA.

- There was no significant main and interaction effect of stream and board of examination of the experimental group with respect to the post-test scores of achievement in Mathematics, as measured by ANOVA.

- There was no significant main and interaction effect of board and mathematical background of the experimental group with respect to the post-test scores of achievement in Mathematics, as measured by ANOVA.

- There were significant differences between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the males and females, as measured by student's t test.

- There were significant differences between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the science and commerce stream of study, as measured by student's t test.

- There were significant differences between the post-test scores of Experimental group and Control group on Achievement in Mathematics based on the state board of examination, however, no significant differences were observed within the experimental and control group who had non-state board of examination as measured by t-test.

- There were significant differences between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the presence and absence of mathematical background, as measured by student's t-test.

Differences in the scores of achievement test between post-test and delayed post intervention of the students of the experimental group.

- An independent t-test was conducted to compare the scores between post-test and delayed post-test and no significant difference between the scores of the experimental group was observed.

Differences in post-test and delayed post-test scores of Experimental group on Achievement test in Mathematics based on demographics of the students

- There were no significant differences between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics based on the males and females, as measured by t-test.

- There were no significant differences between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics based on the study science and commerce stream, as measured by t-test.

- There were no significant differences between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics irrespective of board of examination, as measured by t test.

- There were no significant differences between post-test and delayed post-test scores of Experimental group on Achievement in Mathematics based on the presence and absence of mathematical background, as measured by t test.

B) Post-intervention: Change in attitude towards mathematics attitude after intervention

- In this study, Confidence in Learning Mathematics, Usefulness of Mathematics and Enjoyment of Mathematics was used to measure the attitude towards mathematics in pre and post-intervention scenario.

- There was a statistically significant difference between pre-intervention and post-intervention amongst Experimental group with reference to attitude towards Mathematics.

Confidence in learning mathematics

- In the pre-intervention stage, the students found that mathematics was boring and time consuming. Students complained of stress and headache while attempting mathematics assignment or while attending the mathematics class.

- In a post-intervention stage, students found that mathematics was less boring, agreed to take mathematics as a subject and were confident to taken on any mathematics assignment or test.

- The student's t-test showed that confidence in learning mathematics was significantly different between the pre- and post-intervention stage.

Usefulness of mathematics

- In the pre-intervention stage, availability of opportunities, recommend the subject to friends and to opt for mathematics as a major subject in higher education was not favourable. Many commented on worthlessness and dullness of mathematics as a subject; requiring extra effort, should be an optional subject and knowledge of mathematics not essential were the common perception of students.

- In the post-intervention stage, students found that knowledge of mathematics gave more opportunities, agreed to recommend to friends and choose as a major subject in higher education. However, the choice of mathematics as an optional subject, dull subject and requiring lot of effort were still received with doubt.

- Based on t-test it was found that, usefulness of mathematics in pre- and post-intervention stage was statistically significant, supporting a change in perception after a post-intervention stage.

Enjoyment of mathematics

- During pre-intervention, the majority of students believed that they were unhappy in the mathematics class, which changed to reversed perception with extreme happiness associated with mathematics post intervention. Most of them did not enjoy doing mathematics or thought that mathematics makes them feel easy during pre-intervention. Neither did they enjoy solving mathematical problems.

- In all the parameters, the scores were higher for post-intervention students compared to pre- intervention scores in the students of experimental groups.

- A statistically significant difference was found in the perception of enjoyment of mathematics between the pre- and post-intervention stage. Compared to a pre-intervention stage, in a post-intervention stage, students strongly agreed to being happier, enjoying solving mathematical problems and feeling easy.

C) Post-Intervention: Perception of students on learning mathematics in a Digital Technology Environment using Opinionnaire

An Opinionnaire was prepared and data collected from 40 students of the experimental group.

Demographics for the students of the opinionnaire

- Majority of the students were males (80%), from commerce stream (57.5%), had equally given examination from state and non-state board and 52.5% had a mathematical background.

- 65 % laptops while the remaining owned mobile phones.

- Most of them have been using mobile devices for more than 3 years (70.0%). 62.5 % were very comfortable in using mobile devices and remaining were comfortable in using mobile devices.

- Only one out of the 40 students had attended any online course prior to the intervention.

Usage of Learning Management System (LMS)

- Most of the students (87.5%) had no prior experience in using the LMS facility inside the classroom. The students who had used the LMS have been using it for a period of minimum one year.

- None of the students (100%) had used a Learning Management System for learning outside the classroom.

Usage of mobile device

- The usage of mobile devices for learning purpose inside the classroom was minimal (12.5%). The ones who have used, have been using it for a period of 1 to 3 years.

- About 60% of the students have used mobile device for learning purpose outside the classroom amongst which 79% have used it for more than two years.

Technical inputs on LMS

This construct was measured using multiple factors such as Knowledge of the system and ease of use, Logging in, Layout, Navigation and Content, Connectivity and Accessibility, Use of Mobile Devices in learning, Usefulness of LMS, Assessments, Challenges and Achievements. The perception of the students has been summarized below.

- Knowledge of the system and ease of use: The students had prior briefing of the usage of the system and were comfortable using it for their studies.

- Logging in: They were comfortable using the Wi-Fi and the portal because it did not require multiple passwords. Also setting up and access to the system has been easier since it has a single window

- Layout, Navigation and Content of the LMS: Students were positive about the friendly features, easy navigation, well sequenced and self-explanatory and understandable content.

- Connectivity & Accessibility in LMS: Since accessing LMS did not require any Wi-Fi connection, data usage and downloading of the content into mobile device was satisfactory. The advantage of accessing LMS outside the campus showed positive opinion of students about LMS.

- Use of Mobile devices in learning: Using mobile device, the students felt motivated to spend time for the lessons and were able to accomplish more because the challenging topics became easy. The usage of mobile device in the classroom was greatly appreciated.

- Usefulness of LMS: The students had positive perception; LMS enabled better studies, easy comprehension and deeper learning of the subject, better preparation and guidance, revisiting the topics any time to get a better understanding of the subject.

- Perception on Assessments: Their perception about the tests were changed, as students felt they took the class tests more seriously. Since they could immediately view their results they were constantly inclined to improve their performance. This open test system also helped them communicate with their peers to understand the concepts better.

Perception of learning environment

- Challenges in the perception of learning environment: The disadvantages included entering the mathematical content directly into the device, limited view due to the small size of the screen and toggling between multiple screens.

- Perception on Achievements due to LMS: Students had positive perceptions because there were no restrictions on time and location. This increased the confidence level. Enhanced interaction with the faculty due to better monitoring inside the classroom and through discussion forum outside the classroom have improved their performance. They look forward to a similar learning environment for other courses as well.

Status of the Hypotheses

Hypothesis	***Status***
Hypothesis 1: There is no significant difference between Experimental group and Control group with respect to pre-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 02: There is no significant difference between Experimental group and Control group with respect to post-test scores of achievement in Mathematics.	*Rejected*
Hypothesis 3: There is no significant difference between males and females of Experimental group with respect to post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 04: There is no significant difference between the students of Experimental group who had opted science stream and who had opted commerce stream prior to graduation with respect to the post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 5: There is no significant difference between the students of experimental group from state board and from non-state board prior to graduation with respect to the post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 6: There is no significant difference between the students of the experimental group who had opted mathematics and who had not opted mathematics prior to graduation with respect to the post-test scores of achievement in Mathematics	*Accepted*

Hypothesis 07: There is no significant main and interaction effect of gender and stream of the experimental group with respect to the post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 08: There is no significant main and interaction effect of gender and board of examination of the Experimental group with respect to the post-test scores of achievement in Mathematics	*Accepted (with respect to main effect)* *Rejected (with respect to interaction effect)*
Hypothesis 09: There is no significant main and interaction effect of gender and mathematical background of the experimental group with respect to the post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 10: There is no significant main and interaction effect of the stream and board of examination of the Experimental group with respect to the post-test scores of achievement in Mathematics	*Accepted*
Hypothesis 11: There is no significant main and interaction effect of board of examination and mathematical background of the Experimental group with respect to the post-test scores of achievement in Mathematics.	*Accepted*
Hypothesis 12: There is no significant difference between the post-test scores of Experimental group and Control group on achievement in Mathematics based on the gender.	*Rejected*

Hypothesis 13: There is no significant difference between the post-test scores of achievement in Mathematics of the Experimental group and Control group based on the educational background.	*Rejected except for non-State board students*
Hypothesis 14: There is no significant difference between the post-test and delayed post-test scores of Experimental group with reference to achievement in Mathematics.	*Accepted*
Hypothesis 15: There is no significant difference between post-test and delayed post-test scores of Experimental group on Achievement test in Mathematics based on the gender.	*Accepted*
Hypothesis 16: There is no significant difference between post-test and delayed post-test scores of Experimental group on achievement in mathematics based on the educational background	*Accepted*
Hypothesis 17: There is no significant difference between pre-intervention and post-intervention amongst Experimental group with reference to attitude towards Mathematics.	*Rejected*

5. CONCLUSIONS

Based on the findings of the study, the following conclusions can be drawn.

The effectiveness of digital technology in the achievement of Mathematics of undergraduate management students is positive.

The positive effectiveness of digital technology in the achievement of Mathematics is similar for males and females.

The positive effectiveness of digital technology in the achievement of Mathematics is similar for students of science and commerce.

The positive effectiveness of digital technology in the achievement of Mathematics is similar for students of state board and non-state board of education.

The positive effectiveness of digital technology in the achievement of Mathematics is similar for students who had opted for mathematics and who had not opted for mathematics.

The digital technology treatment has had positive effect on the attitude towards mathematics of undergraduate management students.

The undergraduate management students who were treated in an integrated digital teaching and learning environment had a positive perception towards the digital learning environment.

6. EDUCATIONAL IMPLICATIONS

- An integrated teaching and learning environment in the classroom has reflected a significant effect on the achievement in Mathematics especially with reference to management students. This finding must encourage educators to teach Mathematics to a non-mathematical domain students using digital technology in an integrated framework. This will initiate students towards appreciating the subject better and will find it meaningful when applied in their areas and allied areas of study.

- The findings have well brought out well that digital technology has impacted males and females in a similar fashion despite the pre-intervention scenario which showed that females were less confident in mathematics, found mathematics to be less useful and in general did not enjoy mathematics as much as males. This echoes that educators should not hesitate to employ digital technology in teaching mathematics, the way the researcher has embarked on irrespective of the gender make-up of the students.

- The findings also throws significant light that irrespective of the students prior streams of study, board of examination and whether they had taken mathematics or not, the intervention has impacted everyone in a similar manner. This validates that a pedagogy that integrates digital technology in the way that the researcher has carried out brings all the students irrespective of their educational background to a similar level of engagement and receptiveness especially in the classroom.

- Post-intervention, there was a change in the attitude and perception of respondents towards mathematics. Therefore, a similar integrated digital teaching and learning environment can be encouraged at all levels, including schools.

- Application of mathematics can be found in wide ranges of subject, therefore, LMS supported BYOD learning environment must be encouraged. Further, the same should be applied to other courses in order to increase the capability of students in other areas.

- Inclusion of other Learning Management System supported models and applications must be tested to get a comparative assessment and benefits, such that in case of requirement the framework can be remodelled as per the nature of the course and students.

- The University website should integrate Learning Management System on their site to increase usage.

- In this study Business Mathematics was tested. This experimentation can be replicated for other mathematics courses in the management programme. Therefore, inclusion of additional topics and a gradual increase in the difficulty level of the problems must be encouraged.

- Since this was an online process, immediate feedback on the content of the course, nature of the instructions and assessments and analysis of the assessment can be incorporated to improve the effectiveness of integration of digital technology.

- The assimilation and loading the mathematical content is a challenging process, therefore a committee comprising of technical and academic staff must work together to check for the quality of the content, instructions and accuracy.

- Technical help should be given which can include training to increase the comfortability of the student to toggle between multiple screens irrespective of the devices they use.

- The extent and nature of adopting technology are based on individual differences in social and educational background amongst learners. This study will enable the educators to implement technology-enabled student-centred learning practices, such as assessment, flexible scheduling and pacing, advising, collaborative learning and also, there will be an easy transition from pedagogical practices to heutagogical practices.

- This study has an implication for policy makers. In higher education institutions, the initiative towards investment in ICT infrastructure and to encourage a culture of training and facilitating educators to continually equip with and being aware of the latest technology and instructional strategies must be implemented.

- With respect to students, this study will encourage students to engage in deeper learning and enable them to effectively apply the underlying principles, theories, models, and processes in solving real time problems. Enjoyment and relating mathematics to their respective domain and their active participation will also improve. There would be a transformation from being a passive listener to an active participant

- The Learning Management System DTale with its multitude of technical and non-technical advantages also amplifies its accessibility to all students and faculty absolutely free. Faculty and students can access DTale for any amount of time in the classroom and within the campus with absolute no cost. This is primarily a boon in the education space.

- Educational institutions in the Brick and Mortar format is never ever going to be replaceable. Research has time and again proved it. The perpetual challenge for educators, then, is to make classroom environment more inspiring, more engaging and more exciting for learners. In this light, the positive outcome of the researcher's model, of an integrated digital teaching learning framework is

noteworthy to be complementing or supplementing classroom Face-to-Face teaching and learning mathematics, especially in higher education institutions.

7. DELIMITATIONS OF THE STUDY

The following are the delimitations of the study:

- The study was confined to a limited number of undergraduate management students.
- The study was restricted to the Business Mathematics course of the first year of the undergraduate management program.
- The study had intended to study the effectiveness of digital technology environment in only the students' achievement and improvement in the attitude towards mathematics.
- The study was limited in terms of the duration of the intervention.

8. SUGGESTIONS FOR FUTURE RESEARCH

- Mathematics and its concepts are widely applicable in different fields such as Social Sciences, Arts, and Humanities etc. Whether this study can be extended to study and analyse the change of attitude of students towards mathematics from other non-mathematical domains can be tested.
- Since the Learning Management System approach has been implemented in various schools, the effectiveness of Learning Management System using BYOD – an integrated digital teaching and learning environment in the classroom, at a school level, can also be explored.
- Overall, the study has shown improvement in Mathematical Attitude Scale test scores, post-intervention. But the benefit of such approach in the application of skills, job opportunities or job prospects, and task completion in various industries can be tested.

- Whether the integrated digital teaching and learning environment, will help students to perform better in advanced mathematical concepts, in non-mathematics programmes, at higher education level can be explored.

- There can be study done on the socio-economic and psychological challenges faced by the students of higher education learning in a digital technology environment.

BIBLIOGRAPHY

Akbar, M. (2016). Digital technology shaping teaching practices in higher education. *Frontiers in ICT*, *3*, 1.

Aldheleai, H. F., Bokhari, M. U., & Alammari, A. (2017). Overview of cloud-based learning management system. *International Journal of Computer Applications*, *162*(11).

Alhajri, R. (2016). Prospects and challenges of mobile learning implementation: A case study. Journal of Information Technology & Software Engineering, 6(5), 1-8.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., ... & Wittrock, M. C. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, abridged edition. *White Plains, NY: Longman*.

Anuradha, K. T., & Usha, H. S. (2006). Use of e-books in an academic and research environment: A case study from the Indian Institute of Science. Program, 40(1), 48-62.

Arroyo, I., Burleson, W., Tai, M., Muldner, K., & Woolf, B. P. (2013). Gender differences in the use and benefit of advanced learning technologies for mathematics. *Journal of Educational Psychology*, *105*(4), 957.

Bartlett, M. S. (1954). A note on the multiplying factors for various $\chi 2$ approximations. Journal of the Royal Statistical Society. Series B (Methodological), 296-298.

Basha, H., & Altaf, S. (2012). Prediction of student performance using data mining techniques in higher education domain.

Bhattacharya, I., & Sharma, K. (2007). India in the knowledge economy–an electronic paradigm. International Journal of Educational Management, 21(6), 543-568.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objetives: the classification of educational goals: handbook I: cognitive domain (No. 373.19 C734t). New York, US: D. Mckay.

Buzzard, C., Crittenden, V. L., Crittenden, W. F., & McCarty, P. (2011). The use of digital technologies in the classroom: A teaching and learning perspective. *Journal of Marketing Education*, *33*(2), 131-139.

Casey, A., & Jones, B. (2011). Using digital technology to enhance student engagement in physical education. *Asia-Pacific Journal of Health, Sport and Physical Education*, *2*(2), 51-66.

Chaubey, A., & Bhattacharya, B. (2015). Learning management system in Higher education. *International Journal of Science Technology & Engineering*, *2*(3), 158-162.

Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). How'disruptive innovation'will change the way we learn. *Education Week*, *27*(39), 25-36.

Cilliers, L., Ntlabathi, S., & Makhetha, P. (2017, September). A User Study about the Usage of a Learning Management System in a South African University. In International Symposium on Emerging Technologies for Education, 38-42. Springer, Cham.

Cochrane, T., & Narayan, V. (2011). DeFrosting professional development: reconceptualising teaching using social learning technologies. *Research in Learning Technology*.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16: 297–334.

Cochrane, T. D. (2014). Critical success factors for transforming pedagogy with mobile Web 2.0. British Journal of Educational Technology, 45(1), 6582.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Lawrence Erlbaum; January 15, 1988; 2nd edition.

Collins, A. & Halverson, R. (2009). *Rethinking Education in the Age of Technology: The Digital Revolution and the Schools.* New York: Teachers College Press.

Davidshofer, C. O. and Murphy, K. R., (2005). Psychological testing: Principles and applications, 6th ed. Upper Saddle River, NJ: Pearson.

De Vita, M., Verschaffel, L., & Elen, J. (2014). Interactive whiteboards in mathematics teaching: A literature review. *Education Research International*, *2014*.

Dixon, L. J., Correa, T., Straubhaar, J., Covarrubias, L., Graber, D., Spence, J., & Rojas, V. (2014). Gendered space: The Digital divide between male and female users in internet public access sites. *Journal of Computer-Mediated Communication*, *19*(4), 991-1009.

Dobre, I. (2015). Learning Management Systems for higher education-an overview of available options for Higher Education Organizations. *Procedia-Social and Behavioral Sciences*, *180*, 313-320.

El-Hussein, M., Osman, M., & Cronje, J. C. (2010). Defining mobile learning in the higher education landscape. *Journal of Educational Technology & Society*, *13*(3).

Ellis, R. K. (2009). Field guide to learning management systems. *ASTD Learning Circuits*, 1-8.

Epping, R. (2010). Innovative use of Blackboard® to assess laboratory skills. *Journal of Learning Design*, *3*(3), 32-36.

Field, A. (2013). Discovering statistics using IBM SPSS statistics. Sage.

Francis, J. (2017). The Effects Of Technology On Student Motivation And Engagement In Classroom-Based Learning.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, *19*, 18-26.

Hair, J. F., Jr., R. E. Anderson, R. L. Tatham, and W. C. Black (1992) Multivariate Data Analysis with Readings, 4th edition. Englewood Cliffs, NJ: Prentice Hall.

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing Creativity and Technology in 21st Century Education: A Systemic View for Change. *Journal of Educational Technology & Society*, *19*(3).

Hayes, A.F. (2013) Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. New York, NY: Guilford Press.

Jovanovic, J., & King, S. S. (1998). Boys and Girls in the Performance-Based Science classroom: Who's doing the performing? *American Educational Research Journal*, *35*(3), 477-496.

Kaiser, H. (1970). A second generation little Jiffy. Psychometrika, 35, 401-415.

Khan, M. S. H., Hasan, M., & Clement, C. K. (2012). Barriers to the introduction of ICT into education in developing countries: The example of Bangladesh. *International Journal of instruction*, *5*(2).

Kuenzi, J. J. (2008). Science, technology, engineering, and mathematics (STEM) education: Background, federal policy, and legislative action.

Memon, G. R. (2007). Education in Pakistan: The key issues, problems and the new challenges. *Journal of Management and Social Sciences*, *3*(1), 47-55.

Misra, S., & Joshi, M. K. (1995). Careers in library and information science. *Library and Information Science: an overview*, New Delhi, Ibid, pp. 7-11.

Paas, L. (2008). How Information and Communication Can Support Education for Sustainable Development Current Uses and Trends? International Institute of Sustainable Development. Retrieved from https://www.iisd.org/pdf/2008/ict_education_sd_trends.pdf , accessed on 05.08.2018.

Pahl, C. (2003). Managing evolution and change in web-based teaching and learning environments. *Computers & Education*, *40*(2), 99-114.

Pandey, P., & Pandey, M. M. (2015). Research methodology: Tools and techniques. Romania: Bridge Center.

Peters, M. L. (2013). Examining the relationships among classroom climate, self-efficacy, and achievement in undergraduate mathematics: A multi-level analysis. *International Journal of Science and Mathematics Education*, *11*(2), 459-480.

Sahu, B. (2002). *New Educational Philosophy*. Sarup & Sons.

Samuels, P. (2016). Advice on Exploratory Factor Analysis, Working Paper. http://doi.org/10.13140/RG.2.1.5013.9766.

Setirek, A. C., & Tanrikulu, Z. (2015). Significant Developmental Factors that can Affect the Sustainability of Mobile Learning. Procedia-Social and Behavioral Sciences, 191, 2089-2096

Sevillano-García, M., & Vázquez-Cano, E. (2015). The Impact of Digital Mobile Devices in Higher Education. *Journal of Educational Technology & Society*, *18*(1).

Shankar, D. (2015). Origination, Fertilization and Recommendation of Indian Higher Education. *Journal for Studies in Management and Planning*, *1*(3), 356-362.

Sharma, A., & Vatta, S. (2013). Role of learning management systems in education. *International Journal of Advanced Research in Computer Science and Software Engineering*, *3*(6).

Simpson, E. (1972). The psychomotor domain. *Washington DC: Gryphon House*.

Sitti, S., Sopeerak, S., & Sompong, N. (2013). Development of instructional model based on connectivism learning theory to enhance problem-solving skill in ICT for daily life of higher education students. Procedia-Social and Behavioral Sciences, 103, 315-322.

Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, *8*(2), 16-22.

Vlachopoulos, D., & Makri, A. (2017). The use of games and simulations in higher education can improve students' cognitive and behavioural skills. Impact of Social Sciences Blog.

Woolf, B., Shute, V., VanLehn, K., Burleson, W., King, J. L., Suthers, D., Tonkin, E. (2010). A roadmap for educational technology. In *Computing Community Consortium, Computer Research Association: Commissioned by NSF, May 2010.*